STANLEY G. BENJAMIN - Curriculum Vitae - August 2014

EDUCATION:
Ph.D. Meteorology (1983), Pennsylvania State University, University Park, PA
M.S. Meteorology (1980), Pennsylvania State University, University Park, PA
B.A. Mathematics (1973), Albion College, Albion, Michigan

EXPERIENCE:
Current position

- Chief, Assimilation and Modeling Branch (AMB), Global Systems Division, NOAA Earth Systems Research Laboratory, Boulder, Colorado
    - AMB is the development group for *Rapid Refresh (RAP)*, and *HRRR (High-Resolution Rapid Refresh*) regional models (and previous *RUC* (*Rapid Update Cycle*)), and the *FIM* global model. All of these models are currently, planned, in consideration, or previously were operational models at NOAA/NWS National Centers for Environmental Prediction (NCEP).
    - Various Branch Chief positions (5/92-present) and Research Meteorologist (4/90-present)
- Directing development of the global icosahedral isentropic atmospheric model (FIM – *Flow-following finite-volume Icosahedral Model*) at NOAA, 2005-present. Directing development of the related atmospheric-ocean-chemistry coupled FIM-iHYCOM-chem model.
- Lead on experimental global model development/demonstration for the NOAA HFIP (*Hurricane Forecast Improvement Project*)
- Co-directing development of *HRRR* model (3km *High-Resolution Rapid Refresh*, updated hourly with radar reflectivity assimilation over US). HRRR is planned for NCEP implementation in 2014.
- Directing development of *Rapid Refresh*, which replaced RUC as the NOAA hourly-updated model/assimilation system in May 2012. The development of the Rapid Refresh started in 2005 and continues now. Ongoing improvements to the RAP/HRRR are developed in AMB for high-resolution data assimilation including for radar and near-surface-soil conditions and for boundary layer and cloud, and land-surface modeling.
- Directing applications of HRRR and RAP for aviation/transportation, renewable energy (ongoing wind and solar energy projects for DOE and NOAA), and severe weather forecasting.
- Directed development of the *RUC*, an operational data assimilation/ numerical forecast system running at the NWS National Centers for Environmental Prediction (NCEP), updated in 1994, 1998, and once yearly with major modeling and assimilation changes each year from 2000-2011. The RUC was the first NCEP model that provides analyses and short-range forecasts at high frequency (every 1h) using asynoptic observations (until its replacement by the *Rapid Refresh* model in 2012).
- Developed, with other scientists, objective analysis techniques and numerical prediction models for use in RUC, including initial radar assimilation technique implemented at NCEP (Nov 2008). Performed

research on data assimilation methods for *in situ* and remotely sensed observations, model numerics and parameterizations. Directed projects on RUC applications for aviation, severe weather forecasting, land-surface modeling, wind energy forecasting.

- Research scientist (6/83-4/90) employed by: National Center for Atmospheric Research, Boulder, Colorado working at NOAA, Boulder, CO (formerly PROFS). Performed research on the effects of terrain and soil moisture distribution on short-range forecasts of the regional environment for severe convective storms using the Penn State/NCAR mesoscale model. Studied impact of terrain on local circulations using same model.

MAJOR MODEL TRANSITIONS TO OPERATIONAL NOAA/NCEP STATUS:

- 1994 – NCEP (then NMC) implementation of first version of Rapid Update Cycle (RUC, 60km, 3h cycle). Key aspects: First sub-12h assimilation cycle to run at NCEP, used isentropic coordinates for data assimilation first assimilation/model to use isentropic coordinates in world. Designed for adaptive assimilation of aircraft observations. (Key references: Benjamin 1989, Benjamin et al. 1991)
- 1998 – NCEP implementation of 40km RUC, first 1-h update cycle in world on newly available automated aircraft data and wind profiler data). First use of isentropic-sigma hybrid coordinate for numerical model and data assimilation. First use of multi-species bulk cloud/microphysics parameterization (RUC/RAP are still only models at NCEP to do so.) RUC became backbone for aviation weather model guidance in US. (Key reference: Bleck and Benjamin 1993)
- 2005 – NCEP implementation of 13km RUC. First model at NCEP with cloud assimilation – result: improved overall cloud and ceiling/visibility forecasts.
- 2008 – First assimilation of national-scale radar reflectivity data introduced into NCEP RUC using a radar-latent-heat/ digital filter initialization technique.
- 2010 – Observation impact study using RUC model completed (Ref: Benjamin et al. 2010, NOAA OAR Paper of Year Award). Latest in sequence of Benjamin's studies leading NOAA in regional observation data impact.
- 2012 – NCEP implementation of 13km Rapid Refresh replacing RUC model. Most significant use of community WRF model up to this point at NCEP. Application of community GSI data assimilation but with cloud/radar assimilation component added. Provided hourly updated NOAA guidance for first time over all of North America, including Alaska, Central America and Caribbean Sea.
- 2013 – FIM global model new version applied to National Hurricane Center guidance by NHC request. FIM gave best tropical cyclone track guidance globally among US models for 2013 season.
- 2014 (Feb) – NCEP implementation of RAP version 2 – significant improvement to convective environment and assimilation of surface observations.

- 2014 (planned for Sept) – NCEP implementation planned for 3km hourly updated High-Resolution Rapid Refresh (HRRR) model. An experimental HRRR model has already been transformative for US prediction of severe thunderstorms (by SPC, NWS offices), US National Airspace air traffic management (by FAA), and wind energy guidance for energy community.

OTHER POSITIONS, HONORS:

- NOAA Research Employee of the Year Award (2013) – group award
- Fellow – Cooperative Institute for Research in Environmental Sciences (CIRES, Boulder, CO) (2011)
- Fellow - American Meteorological Society (2004)
- U.S. Department of Commerce Bronze Medals: 1998, 2010
- U.S. Department of Commerce Gold Medal: 2006
- NOAA Research Paper of Year Awards
    - lead author – 2006,
    - 1st co-author – 2008
- Lead for FAA Model Development and Enhancement Research Team (2006-present).
- Member of FAA Aviation Weather Forecasting Task Force, 1985-1987

INVITED SEMINARS:

- 2014 – NOAA Aircraft Data Workshop, Annapolis, MD – Impact of aircraft observations on short-range aviation weather forecasts from NOAA regional models.
- 2013 – American Wind Energy Association – Wind Resource and Projected Energy Assessment Seminar – How do weather models work?
- 2013 – UK Meteorological Office, Reading, UK – Storm-scale hourly updated data assimilation for active convection and the convective environment.
- 2013 – Colorado Scientific Survey, Denver, CO - Ash in the Wind: NOAA development of global/regional atmosphere-soil-vegetation-ocean earth system forecast models including volcanic eruptions
- 2012 – AMS Board on Enterprise Commission – Next-generation model development for NOAA – regional and global
- 2012 – California Independent System Operator (CAISO), Sacramento, CA - Wind and solar forecast improvements from assimilation and modeling enhancements for the NOAA 3km HRRR Model
- 2009-2014 – Utility Variable-Generation Integration Group (UVIG) – an energy industry forum (variablegen.org) for wind/solar energy weather forecasting – NOAA's assimilation and modeling improvements for turbine-level wind and shortwave radiation forecasts
- 2011 – Presentation to Acting Secretary of Commerce (Rebecca Blank) - Next-Generation Weather Model Development at NOAA

- 2011 – Great Lakes Environmental Research Lab – Ann Arbor, MI – seminars on experimental regional (HRRR/RAP/RUC) and global (FIM) models and coupled model/ecosystem interfaces
- 2011 – National Renewable Energy Lab, Golden CO, keynote speaker at national solar energy workshop – NOAA short-range forecasting for shortwave radiation – current and outlook
- 2010 – Hungarian Meteorological Service, Budapest, Hungary – Data assimilation/modeling development and evaluation for the RAP and HRRR model/assimilation systems
- 2009 – Penn State University, University Park, PA – Tarbell Invited Lecture - Development and evaluation of an isentropic icosahedral global model – FIM
- 2009 – University of Washington, Seattle, WA – 2 seminars –
    - HRRR/Rapid Refresh hourly updated assimilation with radar data,
    - Evaluation of the FIM Global Model
- 2009 – WMO Symposium on Nowcasting – Whistler, BC, Canada
- 2007, 2009, 2011 – Alaska Modeling Workshop, Fairbanks, AK
- 2005 – WMO Symposium on Nowcasting – Toulouse, France
- 2003 – HIRLAM Workshop, Helsinki, Finland – Data assimilation in isentropic coordinates
- 2003 – GPS-IPW Workshop, Potsdam, Germany – GPS-Met data impact experiments with the RUC model/assimilation system
- 2003 – Bureau of Meteorology, Melbourne, Australia – An hourly updated data assimilation cycle – the RUC
- 2000 – Météo-France, Toulouse, France – Development of the hourly-updated Rapid Update Cycle isentropic-hybrid model and assimilation

PLANNED WORKSHOP:

- 2008 – Organized and led 4th Workshop on the Use of Isentropic & Other Quasi-Lagrangian Vertical Coordinates in Atmosphere & Ocean Modeling http://www.esrl.noaa.gov/outreach/events/hybridmodeling08/presentations Boulder, CO

OTHER PRESENTATIONS:

- 2014 – Presentation – Intl. Workshop on Subseasonal to Seasonal Prediction – Blocking error in 10-day to 1-year global model forecasts, dependency on resolution and numerics.
- 2014 – Seminar – GFDL – Numerical Weather Prediction at Global and Regional Scales at NOAA/ESRL.
- 2013 – WGNE Workshop on Systematic Errors in Weather and Climate Models, Exeter, UK – Blocking error in 2-30-day global model forecasts and dependency on resolution and numerics - Poster
- 2012 – WMO Workshop on the Impact of Various Observing Systems on NWP, Sedona, AZ - Impact of upper-air and near-surface observations on

short-range forecasts from an hourly assimilation cycle (RUC and Rapid Refresh) - Presentation

- 2001-2012 – Friends and Partners of Aviation Weather – yearly presentations on applications of improved NOAA short-range prediction to aviation hazards
- 1998-2012 – NOAA/NCEP Production Suite Review – yearly updates on model development (RUC, RAP, HRRR, FIM) at this NOAA multi-day review of operational NWP
- 2007 – AMS (American Meteorological Society) Short Course on Aviation Observations – instructor – Aviation observations and NWP
- 2004 – WMO Workshop on Impact of Various Observing Systems on NWP – Alpbach, Austria – Regional observation sensitivity experiments with the RUC assimilation/model
- 1997-2001 – Central Weather Bureau – Taipei – yearly presentations on development of regional mesoscale data assimilation and modeling

REFEREED PUBLICATIONS:

1. Pan, Y., K. Zhu, M. Xue, X. Wang, M. Hu, S.G. Benjamin, S.S. Weygandt, J.S. Whitaker, 2014: A regional GSI-based EnKF-variational hybrid data assimilation system for the Rapid Refresh configuration: Results with a single, reduced resolution. *Mon. Wea. Rev*. 142, accepted for publication.
2. Zhu, K., Y. Pan, M. Xue, X. Wang, J.S. Whitaker, S.G. Benjamin, S.S. Weygandt, M. Hu, **2013**: A regional GSI-based ensemble Kalman filter data assimilation system for the Rapid Refresh configuration: Testing at reduced resolution. *Mon. Wea. Rev*., **141**, 4118-4139.
3. Hamill, T.M., J.S. Whitaker, D. Kleist, M. Fiorino, S.G. Benjamin, **2011**: Predictions of 2010's tropical cyclones using the GFS and ensemble-based data assimilation methods. *Mon. Wea. Rev*., **139,** 3243-3247.
4. Hamill, T.M., J.S. Whitaker, M. Fiorino, S.G. Benjamin, **2011**: Global Ensemble Predictions of 2009's Tropical Cyclones Initialized with an Ensemble Kalman Filter, *Mon. Wea. Rev*., **139**, 668-688.
5. Pondeca, M.S.F.V. de, G.S. Manikin, G. DiMego, S.G. Benjamin, D.F. Parrish, R.J. Purser, W.-S. Wu, J. Horel, Y. Lin, R.M. Aune, D. Keyser, L. Anderson, B. Colman, G. Mann, and J. Vavra, **2011**: The Real-Time Mesoscale Analysis at NOAA's National Centers for Environmental Prediction: Current Status and Development. *Wea. Forecasting*, **26**, 593-612.
6. Bleck, R., S. Benjamin, J.-L. Lee, A.E. MacDonald; **2010**: On the use of an adaptive, hybrid-isentropic vertical coordinate in global atmospheric modeling. *Mon. Wea. Rev.*, **138**, 2188-2210.
7. Benjamin, S.G., B.D. Jamison, W.R. Moninger, S. R. Sahm, B. Schwartz, T.W. Schlatter, **2010**: Relative short-range forecast impact from aircraft, profiler, radiosonde, VAD, GPS-PW, METAR, and mesonet observations via the RUC hourly assimilation cycle. *Mon. Wea. Rev.*, **138**, 1319-1343.
8. Moninger, W.R., S.G. Benjamin, B.D. Jamison, T.W. Schlatter, T.L. Smith, and E.J. Szoke, **2010**: Evaluation of regional aircraft observations using TAMDAR. *Wea. Forecasting*, **25**, 647-655.
9. Stensrud, D., M. Xue, L. Wicker, K. Kelleher, M. Foster, J. Schaefer, R. Schneider, S. Benjamin, S. Weygandt, J. Ferree, J. Tuell, **2009**: Convective-scale Warn-on-Forecast: A Vision for 2020. *Bull. Amer. Meteor. Soc.,* **90**, 1487-1499. doi: 10.1175/2009BAMS2795.1
10. Smith, T.L., S.G. Benjamin, S.I. Gutman, and S. Sahm, **2007**: Short-range forecast impact from assimilation of GPS-IPW observations into the Rapid Update Cycle. *Mon. Wea. Rev.*, **135**, 2914-2930. (NOAA Research Paper of Year Award – 2008)
11. Lu, C., H. Yuan, B.E. Schwartz, and S.G. Benjamin, **2007**, Short-range numerical weather prediction using time-lagged ensembles, *Wea. Forecasting,* **22**, 580-595.
12. Stensrud, D.J., N. Yussouf, M.E. Baldwin, J.T. McQueen, J. Du, B. Zhou, B. Ferrier, G. Manikin, F.M. Ralph, J.M. Wilczak, A.B. White, I. Djalalova, J. Bao, R. Zamora, S. Benjamin, P.A. Miller, T.L. Smith, T. Smirnova, M. F. Barth, **2006**: The New England High-Resolution Temperature Program. *Bull. Amer.*

Meteor. Soc., **87**, 491-498.
13. Benjamin, S.G., D. Devenyi, S.S. Weygandt, K.J. Brundage, J.M. Brown, G. Grell, D. Kim, B.E. Schwartz, T.G. Smirnova, T.L. Smith, G.S. Manikin, **2004**: An hourly assimilation/forecast cycle: the RUC. *Mon. Wea. Rev.,* **132**, 495-518. (NOAA Research Paper of Year Award – 2006).
14. Benjamin, S.G., G.A. Grell, J.M. Brown, T.G. Smirnova, and R. Bleck, **2004**: Mesoscale weather prediction with the RUC hybrid isentropic/terrain-following coordinate model. *Mon. Wea. Rev.*, **132**, 473-494.
15. Benjamin, S.G., B.E. Schwartz, E.J. Szoke, and S.E. Koch, **2004**: The value of wind profiler data in U.S. weather forecasting. *Bull. Amer. Meteor. Soc.*, **85**, 1871-1886.
16. Benjamin, S.G., B.E. Schwartz, E.J. Szoke, and S.E. Koch, **2004**: The value of wind profiler data in U.S. weather forecasting. Case studies. (online supplement). *Bull. Amer. Meteor. Soc.*, **85**, E21-E29.
17. Devenyi, D., and S.G. Benjamin, **2003**: A 3-dimensional atmospheric variational assimilation technique in a hybrid isentropic-sigma coordinate. *Meteor. and Atmospheric Physics*, **82**, 245-257.
18. Gutman, S.I. and S.G. Benjamin, **2001**: The role of ground-based GPS meteorological observations in numerical weather prediction. *GPS Solutions,* **4**, 16-24.
19. Schwartz, B.E., S.G. Benjamin, S.M. Green, and M.R. Jardin, **2000**: Accuracy of RUC-1 and RUC-2 wind and aircraft trajectory forecasts by comparison with ACARS observations. *Wea. Forecasting*, **15**, 313-326.
20. Smirnova, T.G., J.M. Brown, S.G. Benjamin, and D. Kim, **2000**: Parameterization of cold-season processes in the MAPS land-surface scheme. *J. Geophys. Res.*, **105, D3,** 4077-4086.
21. Smith, T.L., S.G. Benjamin, B.E. Schwartz, and S.I. Gutman, **2000**: Using GPS-IPW in a 4-D data assimilation system. *Earth, Planets, and Space,* **52**, 951-956.
22. Berbery, E.H., K. Mitchell, S. Benjamin, T. Smirnova, H. Ritchie, R. Hogue, and E. Radeva, **1999**: Assessment of land-surface energy budgets from regional and global models. *J. Geophys. Res.*, **104,** 19329-19348.
23. Benjamin, S.G., B.E. Schwartz, and R.E. Cole, **1999**: Accuracy of ACARS wind and temperature observations determined by collocation. *Wea. Forecasting,* **14**, 1032-1038.
24. Smirnova, T.G., J.M. Brown, and S.G. Benjamin, **1997**: Performance of different soil model configurations in simulating ground surface temperature and surface fluxes. *Mon. Wea. Rev.*, **125**, 1870-1884.
25. Westphal, D.L., S. Kinne, J.M. Alvarez, P. Minnis, D.F. Young, S.G. Benjamin, W.L. Eberhard, R.A. Kropfli, S.Y. Matrosov, J.B. Snider, T.A. Uttal, A.J. Heymsfield, G.G. Mace, S.H. Melfi, D.O`C. Starr, and J.J. Soden, **1996**: Initialization and validation of a simulation of cirrus using FIRE-II data. *J. Atmos. Sci.*, **53**, 3397-3429.
26. Schwartz, B., and S. G. Benjamin, **1995**: A comparison of temperature and wind measurements from ACARS-equipped aircraft and rawinsondes. *Wea. Forecasting*, **11**, 528-544.

27. Pan, Z.-T., S. G. Benjamin, J. M. Brown, and T. G. Smirnova, **1994**: Comparative experiments with MAPS on different parameterization schemes for surface moisture flux and boundary-layer processes. *Mon. Wea. Rev.*, **122**, 449-470.
28. Schlatter, T. W., and S. G. Benjamin, **1994**: A mesoscale data assimilation system adapted for trajectory calculations over Alaska. U.S. Geological Survey Bulletin, **2047**, 269-276.
29. Bleck, R., and S. G. Benjamin, **1993**: Regional weather prediction with a model combining terrain-following and isentropic coordinates. Part I: model description. *Mon. Wea. Rev.*,**121**, 1770-1785.
30. Benjamin, S. G., T. L. Smith, P. A. Miller, D. Kim, T. W. Schlatter, D. Dévényi, J.-M. Carrière, R. Bleck, **1993**: Recent developments in the MAPS isentropic-sigma data assimilation system. *Időjárás*, **97**, 1-19.
31. Smith, T. L., and S. G. Benjamin, **1993**: Impact of network profiler data on a 3-h data assimilation system. *Bull. Amer. Meteor. Soc.*, **74**, 801-807.
32. Miller, P.A., and S.G. Benjamin, **1992**: A system for the hourly assimilation of surface observations in mountainous and flat terrain. *Mon. Wea. Rev.*, **120**, 2342-2359.
33. Benjamin, S. G., K. A. Brewster, R. L. Brummer, B. F. Jewett, T. W. Schlatter, T. L. Smith, and P. A. Stamus, **1991**: An isentropic three-hourly data assimilation system using ACARS aircraft observations. *Mon. Wea. Rev.*, **119**, 888-906.
34. Benjamin, S. G., and P. A. Miller, **1990**: An alternate sea-level pressure reduction and a statistical comparison of surface geostrophic wind estimates with observed winds. *Mon. Wea. Rev.*, **118**, 2099-2116.
35. Benjamin, S. G., **1989**: An isentropic meso-alpha scale analysis system and its sensitivity to aircraft and surface observations. *Mon. Wea. Rev.*, **117**, 1586-1603.
36. Benjamin, S. G. and T. N. Carlson, **1986**: Some effects of surface heating and topography in the regional severe storm environment. Part I: three-dimensional simulations. *Mon. Wea. Rev.*, **114**, 307-329.
37. Benjamin, S. G., **1986**: Some effects of surface heating and topography on the regional severe storm environment. Part II: two-dimensional idealized experiments. *Mon. Wea. Rev.*, **114**, 330-343.
38. Benjamin, S. G. and N. L. Seaman, **1985**: A simple scheme for objective analysis in curved flow. *Mon. Wea. Rev.*, **113**, 1184-1198.
39. Carlson, T. N., S. G. Benjamin, G. S. Forbes and Y.-F. Li, **1983**: Elevated mixed layers in the regional severe storm environment: Conceptual model and case studies. *Mon. Wea. Rev.*, **111**, 1453-1473.
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41. Carlson, T. N., J. K. Dodd, S. G. Benjamin and J. N. Cooper, **1981**: Satellite estimation of the surface energy balance, moisture availability and thermal inertia. *J. Appl. Meteor.*, **20**, 67-87.
42. Carlson, T. N. and S. G. Benjamin, **1980**: Radiative heating rates for Saharan

dust. *J. Atmos. Sci.*, **37**, 193-213.
43. Carlson, T. N., R. A. Anthes, M. Schwartz, S. G. Benjamin and D. G. Baldwin, **1980**: Analysis and prediction of severe storms environment. *Bull. Amer. Meteor. Soc.*, **61**, 1018-1032.

Currently working on papers with the following themes:

a. Description and idealized tests of the global FIM – Flow-following finite-volume Icosahedral Model
b. Real-data evaluation of the global FIM model
c. Rapid Refresh hourly updated model/assimilation system
d. Assimilation of radar reflectivity via radar-DFI latent heating
e. HRRR hourly updated storm-permitting model for applications in aviation, severe weather and energy
f. RUC land-surface model for use in regional and global applications
g. Assimilation of surface observations through physical coupling with PBL and soil
h. Cloud/hydrometeor assimilation

Web of Science H-index: 22
Google Scholar H-index: 32